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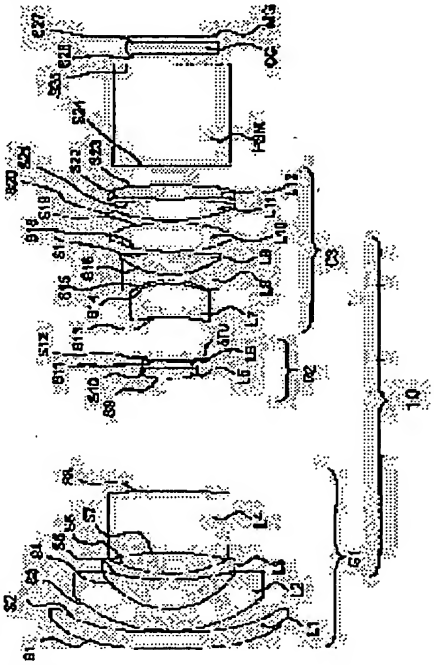
(54) RETROFOCUS TYPE LENS AND PROJECTION TYPE DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a retrofocus type lens having long back focal length with reference to a focal distance, having telecentricity on a video source side and realizing wide viewing angle projection.

SOLUTION: A 1st negative group lens G1 has an aspherical lens L. negative lenses L2 and L3 being a meniscus convex to a large conjugate side and a negative lens L4 being a meniscus convex to a small conjugate side. A 2nd positive group lens G2 has a positive lens L5 and a lens L6 bonded with the lens L5. A 3rd positive group lens G3 has a positive lens L7 being a meniscus convex to the small conjugate side, a biconcave lens L8, a positive lens L9 bonded with the lens L8, a biconvex lens L10, a biconvex lens L11 and an aspherical lens L12. When it is assumed that f, f1, f2, and f3 are the focal distances of the entire system and the respective groups, and f4 and f5 are the axial focal distances of the lenses L1 and L12, this lens satisfies 0.8<f2/f3<1.5, 1.6<|f1|/f<2.4, |f4|/f>30 and f5/f>6.



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CLAIMS

[Claim(s)]
[Claim 1] In the retro focus mold lens which has arranged in order the 1st group lens which has negative refractive power, the 2nd group lens which has forward refractive power, and the 3rd group lens which has forward refractive power toward a small conjugation side from the big conjugation side The 1st lens with which said 1st group lens includes the aspheric surface in order toward a small conjugation side from a big conjugation side, It has negative refractive power. To a big conjugation side The 2nd lens of the shape of a meniscus of a convex, It has negative refractive power. To a big conjugation side The 3rd lens of the shape of a meniscus of a convex, The 5th lens with which it has negative refractive power, and has the 4th lens of the shape of a meniscus of a convex in a small conjugation side, and said 2nd group lens has forward refractive power in order toward a small conjugation side from a big conjugation side, It has the 6th lens joined to this 5th lens, and said 3rd group lens has forward refractive power in order toward a small conjugation side from a big conjugation side. To a small conjugation side The 7th lens of the shape of a meniscus of a convex, The 8th lens of both concaves, and the 9th lens which is joined to this 8th lens and has forward refractive power, It has the 10th lens of both convexes, the 11th lens of both convexes, and the 12th lens including the aspheric surface. The focal distance of said 2nd group lens, and f3 for the focal distance of the lens whole system, and f2 The focal distance of said 3rd group lens, [f] | the time of making the absolute value of the focal distance of said 1st group lens, and |f4| into the absolute value of the shaft top focal distance of said 1st lens, and making f5 into the shaft top focal distance of said 12th lens for f1| — the following conditional expression (1), (2), and (3) — and (4) —
0.8<f2/f3 <1.5 — (1)
1.6<|f1| / f< 2.4 — (2)
| f4| / f> 30 — (3)
f5/f> 6 — (4)
The retro focus mold lens characterized by being satisfied.
[Claim 2] from the image surface by the side of small conjugation [in / it extracts between said 2nd group lenses and said 3rd group lenses, and a means is arranged, and / for |EXP| / the lens whole system] — this — small — the time of considering as the absolute value of the distance to the pupil surface by the side of **** conjugation — the following conditional expression (5)
| EXP| / f> 50 — (5)
The retro focus mold lens according to claim 1 characterized by being satisfied.
[Claim 3] When BFL is made into the back focal length of the lens whole system, it is the following conditional expression (6).
BFL/f> 2 — (6)
Claim 1 characterized by being satisfied, or a retro focus mold lens given in either of 2.
[Claim 4] The Abbe number in d line of the ** material which constitutes said 4th lens for nu 4, the Abbe number in d line of the ** material which constitutes said 5th lens for nu 5, The Abbe number in d line of the ** material which constitutes said 7th lens for nu 7, the Abbe number in d line of the ** material which constitutes said 8th lens for nu 8, (11) 11 [the following conditional expression (7), (8),

(9), (10), and] When the Abbe number in d line of the ** material which constitutes said 9th lens for nu 9, and nu 10 are made into the Abbe number in d line of the ** material which constitutes said 10th lens, reach (12).

15 — < — nu 4 <30 — (7)

15 — < — nu 5 <30 — (8)

40 — < — nu 7 <100 — (9)

15 — < — nu 8 <32 — (10)

20 — < — nu 9 <50 — (11)

70 — < — nu10<100 — (12)

A retro focus mold lens given in either to claims 1–3 characterized by being satisfied.

[Claim 5] In the system of coordinates which considered as the parameter showing the anomalous–scattering nature of the ** material which constitutes the m–th lens (m= 4, 5, 8, 10) for dPgFm, and took the partial dispersion ratio PgF from an F line to g line for Abbe number nud in d line along the axis of ordinate for the axis of abscissa When PgFma (nud) shows the abnormality partial dispersion ratio of the ** material which shows the straight line showing a normal partial dispersion ratio by PgFn (nud), and shows the anomalous–scattering nature which constitutes the m–th lens in Abbe number nud in d line, it is dPgFm=PgFma(nud)–PgFn (nud).

(15) 15 [the following conditional expression (13) (14), and] Come out, be and reach (16).

0.008<dPgF4 <0.03 — (13)

0.01 <DPgF5 <0.025 — (14)

0.01 <DPgF8 <0.02 — (15)

0.03 <DPgF 10< 0.055 — (16)

The retro focus mold lens according to claim 4 characterized by being satisfied.

[Claim 6] In the system of coordinates which considered as the parameter showing the anomalous–scattering nature of the ** material which constitutes the m–th lens (7 m= 9) for dPgFm, and took the partial dispersion ratio PgF from an F line to g line for Abbe number nud in d line along the axis of ordinate for the axis of abscissa When PgFma (nud) shows the abnormality partial dispersion ratio of the ** material which shows the straight line showing a normal partial dispersion ratio by PgFn (nud), and shows the anomalous–scattering nature which constitutes the m–th lens in Abbe number nud in d line, it is dPgFm=PgFma(nud)–PgFn (nud).

Conditional expression [following] (17) Come out, be and reach (18).

– 0.01 <dPgF 7< 0.045 — (17)

– 0.015<dPgF 9< 0.02 — (18)

Claim 4 characterized by being satisfied, or a retro focus mold lens given in either of 5.

[Claim 7] The projection mold display characterized by equipping with the retro focus mold lens of a publication either to claims 1–6 which carry out expansion projection of the modulation flux of light which was penetrated or reflected by the light source, the light valve illuminated by the outgoing beam of this light source, and this light valve, and was modulated two–dimensional.

[Claim 8] Said light valve is a projection mold display according to claim 7 characterized by being a liquid crystal light valve.

[Claim 9] Said light valve is a projection mold display according to claim 7 characterized by having a mirror array containing the unit mirror in which two or more inclinations are possible.

[Claim 10] Said light valve is a projection mold display according to claim 7 characterized by having a grating array containing the unit grating two or more amounts of modulation phases of whose are adjustable.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the retro focus mold lens suitable for the projection optical system which needs long back focal length compared with a focal distance, and the projection mold display which carried this.
[0002]
[Description of the Prior Art] Drawing 13 is the block diagram showing roughly the optical system of the conventional projection mold indicating equipment (liquid crystal projector). it is shown in drawing 13 — as — this projection mold display 300 — from a lamp 120 and a reflecting mirror 130 — becoming — abbreviation — it has the light source 1 which carries out outgoing radiation of the parallel illumination-light bundle 2, dichroic mirrors 3B and 3G, and the mirrors 4a, 4b, and 4c which reflect light. Moreover, transparency mold liquid crystal panel 5R as which the projection mold display 300 displays the image for red, By reflecting transparency mold liquid crystal panel 5G which display the image for green, transparency mold liquid crystal panel 5B which displays the image for blue, and red light 2R and blue glow 2B, and making green light 2G penetrate It has the dichroic prism 6 which outputs the flux of light 20 by which red (R), green (G), and blue (B) were compounded, and the projection lens 7 which carries out expansion projection of the incoming beams 20 on a screen 8. In addition, in drawing, 200 shows a case.
[0003] Dichroic mirror 3B reflects blue glow 2B of the flux of lights 2 by which outgoing radiation was carried out from the light source 1, and makes red light 2R and green light 2G penetrate. It reflects by mirror 4b, and blue glow 2B reflected by dichroic mirror 3B penetrates liquid crystal panel 5B, and it carries out incidence to a dichroic prism 6. Dichroic mirror 3G reflect green light 2G which penetrated dichroic mirror 3B, and make red light 2R penetrate. Green light 2G reflected by dichroic mirror 3G penetrate liquid crystal panel 5G, and they carry out incidence to a dichroic prism 6. It reflects by Mirrors 4a and 4c, and red light 2R which penetrated dichroic mirror 3B penetrates liquid crystal panel 5R, and it carries out incidence to a dichroic prism 6. A dichroic prism 6 turns and carries out outgoing radiation of red light 2R which carried out incidence, green light 2G, and the flux of light 20 which compounded blue glow 2B to the projection lens 7. The projection lens 7 expands the synthetic flux of light 20, and projects it on a screen 8.
[0004]
[Problem(s) to be Solved by the Invention] In the above-mentioned projection mold indicating equipment, since it is necessary to arrange the thick dichroic prism 6 between the projection lens 7 and the liquid crystal panels 5R, 5G, and 5B as a light valve component which is a source of an image, long back focal length is required of the projection lens 7.
[0005] Moreover, when applying the above-mentioned projection mold indicating equipment to a rear projector (tooth-back projection mold indicating equipment), the one where the distance from the projection lens 7 to [from a viewpoint of not enlarging the dimension of equipment as much as possible] a screen 8 is shorter (that is, the projection lens 7 is a wide angle) is desirable.
[0006] furthermore, it is designed so that the illumination-light bundle which carries out incidence to

liquid crystal panels 5R, 5G, and 5B may turn into the abbreviation parallel flux of light (that is, telecentric lighting is made — as), since spectral transmittance, a polarization generation property, and a reflection factor are large and a dichroic prism 6 changes according to the incident angle of the flux of light. In this case, the flux of light which carries out incidence to the projection lens 7 is the abbreviation parallel flux of light. If the conventional wide angle projection lens with short back focal length is used for such optical system, the flux of light which penetrates the screen periphery of liquid crystal panels 5R, 5G, and 5B, and carries out incidence to the projection lens 7 will decrease extremely, and the screen periphery of a projection image will become dark. Therefore, a configuration (configuration with tele cent rucksack nature) in which the chief ray of the flux of light which carries out incidence becomes abbreviation parallel from each location of the source of an image to the optical axis of the projection lens 7 is desired. For this reason, the distance from liquid crystal panels 5R, 5G, and 5B to a pupil location is required for the projection lens of a configuration big enough compared with a focal distance.

[0007] as mentioned above — the projection lens used for a projection mold indicating equipment — (1) extensive field angle nature and (2) — it is required that the basic specification about the tele cent rucksack nature by the side of big back focal length and (3) image-display component should be satisfied. Moreover, the basic aberration engine performance indicated from following (4) by (7) is also required of the projection lens of a projection mold display.

[0008] (4) low chromatic-aberration: — the projection scale-factor difference of the primary color pixel of a projection image becomes sufficiently small — as — typical — pixel pitch extent — moreover, it is desirably required for below one half of a pixel pitch to control the chromatic aberration of magnification. Moreover, to use an extra-high pressure mercury lamp, for example for the source of the illumination light, it is necessary to carry out chromatic-aberration-of-magnification amendment, taking into consideration balance with the chromatic aberration of magnification by the side of red also about such a bright-line-spectrum component with a strong spectrum wavelength [shorter than the original spectrum wavelength (450nm - about 470nm) of blue glow], for example, g line (436nm) of mercury near, and to control the flare component of a purple-blue color (Violet). Furthermore, it is required to control vertical chromatic aberration small so that the focusing point for every primary color may be in agreement.

[0009] (5) Low distortion aberration : with the wide angle lens for rear projectors, since a rectangle-like projection image is projected inside the frame of a projection screen, the distortion aberration of a screen periphery tends to be conspicuous. Therefore, controlling typically the gap from the ideal point of the pixel by distortion aberration to pixel pitch extent is called for. Moreover, controlling distortion aberration by the rear projector used for CAD and the multi-vision projector to which arrange the unit screen by which rear projection was carried out, and the number of pixels is made to increase so that the absolute deviation from an ideal point serves as below one half extent of a pixel pitch is called for.

[0010] (6) usable: in a large temperature requirement — in order to cope with generation of heat with various installation temperature environments of a projector, and the lamp for lighting, the consideration on a design which maintains desired optical-character ability over the temperature requirement where a projection lens is large is called for. In order to solve the problem of these operating temperature limits, there is the approach of constituting a projection lens only from a glass lens. Generally, compared with plastic material, a glass lens's expansion and refractive-index change to a temperature change are small, and are advantageous to maintenance of a stable optical property. However, when using the aspheric surface for various aberration amendments, the glass lens is disadvantageous in cost. then — the lens system of this application — a plastics aspheric lens — various aberration amendments — carrying out — in addition — and the focus gap by the temperature change realizes a small projection lens.

[0011] (7) High resolution : in order to carry out expansion projection of the subject-copy image of the light valve component which has the number of pixels which are the high density and many pixels of the 1 million-pixel class to which development is progressing in recent years, the high resolution projection lens according to the detailed pixel structure of a light valve is called for. In order to secure the high

resolution nature of a projection lens, it is necessary to also fully amend the chromatic aberration mentioned above, shaft top aberration other than distortion aberration, and the various aberration outside a shaft.

[0012] Then, it is made in order to cancel the technical problem of the conventional technique which was described above, and to a focal distance, back focal length is long, and has tele cent rucksack nature by the source side of an image, and this invention aims at offering the retro focus mold lens in which extensive field angle projection is possible, and the projection mold display using this lens.

[0013]

[Means for Solving the Problem] The retro focus mold lens concerning claim 1 The 1st group lens which has negative refractive power, and the 2nd group lens which has forward refractive power, The 1st lens with which the 3rd group lens which has forward refractive power is arranged in order toward a small conjugation side from a big conjugation side, and said 1st group lens includes the aspheric surface in order toward a small conjugation side from a big conjugation side, It has negative refractive power. To a big conjugation side The 2nd lens of the shape of a meniscus of a convex, It has negative refractive power. To a big conjugation side The 3rd lens of the shape of a meniscus of a convex, The 5th lens with which it has negative refractive power, and has the 4th lens of the shape of a meniscus of a convex in a small conjugation side, and said 2nd group lens has forward refractive power in order toward a small conjugation side from a big conjugation side, It has the 6th lens joined to this 5th lens, and said 3rd group lens has forward refractive power in order toward a small conjugation side from a big conjugation side. To a small conjugation side The 7th lens of the shape of a meniscus of a convex, The 8th lens of both concaves, and the 9th lens which is joined to this 8th lens and has forward refractive power, It has the 10th lens of both convexes, the 11th lens of both convexes, and the 12th lens including the aspheric surface. The focal distance of said 2nd group lens, and f3 for the focal distance of the lens whole system, and f2 The focal distance of said 3rd group lens, [f] | the time of making the absolute value of the focal distance of said 1st group lens, and |f4| into the absolute value of the shaft top focal distance of said 1st lens, and making f5 into the shaft top focal distance of said 12th lens for f1| — the following conditional expression (1), (2), and (3) — and (4) —

0.8<f2/f3 <1.5 — (1)

1.6<|f1| / f< 2.4 — (2)

| f4| / f> 30 — (3)

f5/f> 6 — (4)

It is characterized by being satisfied.

[0014] moreover — from the image surface by the side of small conjugation [in / the retro focus mold lens concerning claim 2 is stopped down between said 2nd group lenses and said 3rd group lenses, and a means is arranged, and / for |EXP| / the lens whole system] — this — small — the time of considering as the absolute value of the distance to the pupil surface by the side of **** conjugation — the following conditional expression (5)

| EXP| / f> 50 — (5)

It is characterized by being satisfied.

[0015] Moreover, the retro focus mold lens concerning claim 3 is the following conditional expression (6), when BFL is made into the back focal length of the lens whole system.

BFL/f> 2 — (6)

It is characterized by being satisfied.

[0016] Moreover, the retro focus mold lens concerning claim 4 The Abbe number in d line of the ** material which constitutes said 4th lens for nu 4, the Abbe number in d line of the ** material which constitutes said 5th lens for nu 5, The Abbe number in d line of the ** material which constitutes said 7th lens for nu 7, the Abbe number in d line of the ** material which constitutes said 8th lens for nu 8, (11) 11 [the following conditional expression (7), (8), (9), (10), and] When the Abbe number in d line of the ** material which constitutes said 9th lens for nu 9, and nu 10 are made into the Abbe number in d

line of the ** material which constitutes said 10th lens, reach (12).
15 — < — nu 4 <30 — (7)
15 — < — nu 5 <30 — (8)
40 — < — nu 7 <100 — (9)
15 — < — nu 8 <32 — (10)
20 — < — nu 9 <50 — (11)
70 — < — nu10<100 — (12)
It is characterized by being satisfied.
[0017] Moreover, the retro focus mold lens concerning claim 5 In the system of coordinates which considered as the parameter showing the anomalous-scattering nature of the ** material which constitutes the m-th lens (m= 4, 5, 8, 10) for dPgFm, and took the partial dispersion ratio PgF from an F line to g line for Abbe number nud in d line along the axis of ordinate for the axis of abscissa When PgFma (nud) shows the abnormality partial dispersion ratio of the ** material which shows the straight line showing a normal partial dispersion ratio by PgFn (nud), and shows the anomalous-scattering nature which constitutes the m-th lens in Abbe number nud in d line dPgFm=PgFma(nud)-PgFn (nud) — it is — the following conditional expression (13), (14), and (15) — and (16) —
0.008<dPgF4 <0.03 — (13)
0.01 <DPgF5 <0.025 — (14)
0.01 <DPgF8 <0.02 — (15)
0.03 <DPgF 10< 0.055 — (16)
It is characterized by being satisfied.
[0018] Conditional expression [following] (17) Moreover, the retro focus mold lens concerning claim 6 reaches (18).
- 0.01 <dPgF 7< 0.045 — (17)
- 0.015<dPgF 9< 0.02 — (18)
It is characterized by being satisfied.
[0019] Moreover, the projection mold indicating equipment concerning claim 7 is characterized by equipping with the retro focus mold lens of a publication either to claims 1-6 which carry out expansion projection of the modulation flux of light which was penetrated or reflected by the light source, the light valve illuminated by the outgoing beam of this light source, and this light valve, and was modulated two-dimensional.
[0020] Moreover, the projection mold indicating equipment concerning claim 8 is characterized by using said light valve as a liquid crystal light valve.
[0021] Moreover, the projection mold indicating equipment concerning claim 9 is characterized by having the mirror array in which said light valve contains the unit mirror in which two or more inclinations are possible.
[0022] Moreover, the projection mold indicating equipment concerning claim 10 is characterized by having the grating array in which said light valve contains the unit grating two or more amounts of modulation phases of whose are adjustable.
[0023]
[Embodiment of the Invention] Drawing 1 is the block diagram showing roughly the retro focus mold lens 10 to the gestalten 1-5 of operation of this invention. As shown in drawing 1 , the retro focus mold lens 10 to the gestalten 1-5 of operation has the structure which turned to the small conjugation side the 1st group lens G1 which has negative refractive power, the 2nd group lens G2 which has forward refractive power, Diaphragm STO (S12 shows a diaphragm side.), and 3rd group lens G3 which has forward refractive power, and has arranged it in order from the big conjugation side. Here, "a big conjugation side" means the outgoing radiation side (left-hand side in the screen side in the projection mold display which uses a retro focus mold lens as a projection lens, i.e., drawing 1) of projection light, and "a small conjugation side" means the incidence side (right-hand side in the light valve side in the

projection mold display which uses a retro focus mold lens as a projection lens, i.e., drawing 1) of projection light.

[0024] The 1st lens L1 which has negative refractive power weak near [where the 1st group lens G1 has been arranged sequentially from a big conjugation side] the core, It has negative refractive power, has the 2nd lens L2 of the shape of a meniscus of a convex, and negative refractive power in a big conjugation side, has the 3rd lens L3 of the shape of a meniscus of a convex, and negative refractive power in a big conjugation side, and has the 4th lens L4 of the shape of a meniscus of a convex in a small conjugation side.

[0025] The 2nd group lens G2 has the 5th lens L5 which has forward refractive power, and 6th lens L6 joined to this 5th lens L5.

[0026] 3rd group lens G3 has the forward refractive power arranged sequentially from a big conjugation side. To a small conjugation side The 7th lens L7 of the shape of a meniscus of a convex, It has the 8th lens L8 of both concaves, the 9th lens L9 which is joined to this 8th lens L8, and has forward refractive power, the 10th lens L10 of both convexes, the 11th lens L11 of both convexes, and the 12th lens L12 that has forward refractive power weak near the core.

[0027] The retro focus mold lens 10 to the gestalten 1-5 of operation The focal distance of the 2nd group lens G2, and f3 for the focal distance of the lens whole system, and f2 The focal distance of 3rd group lens G3, [f] | the time of making the absolute value of the focal distance of the 1st group lens G1, and |f4| into the absolute value of the shaft top focal distance of the 1st lens L1, and making f5 into the shaft top focal distance of the 12th lens L12 for f1| — the following conditional expression (1), (2), and (3) — and (4) —

0.8 <F2/F3 — < — 1.5 — (1)

1.6 <|F1|/F — < — 2.4 — (2)

| f4| / f> 30 — (3)

f5/f> 6 — (4)

It is constituted so that it may be satisfied.

[0028] In such a retro focus mold lens 10, it is possible to secure the long back focal length who can arrange Prism PSM between a projection lens and a light valve in spite of an extensive field angle and a short focal distance. Moreover, the chief ray of the flux of light from each image quantity which carries out incidence to a projection lens from a light valve can lose the bad influence to the projection image with which a high ambient light quantitative ratio can be secured, and it originates in the optical property change by the incident angle property of said prism PSM from their being abbreviation parallel to an optical axis. moreover, the 1st lens L1 and the 12th lens L12 — small lens number of sheets can also amend spherical aberration, distortion aberration, and many high order aberration to altitude by establishing the aspheric surface in each both sides.

[0029] If the conditions for maintaining tele cent rucksack nature are shown and an upper limit is exceeded while conditional expression (1) secures long back focal length, it becomes strong too much, and while the configuration of the tele cent rucksack which maintains the chief ray besides a shaft at abbreviation parallel becomes difficult, it will become difficult to amend [of distortion aberration] the forward refractive power of 3rd group lens G3. Moreover, it becomes difficult for the forward refractive power of 3rd group lens G3 to become weak too much, if a minimum is exceeded, and for the configuration of a retro focus mold to become weak, and to secure long back focal length.

[0030] Conditional expression (2) is the conditions for securing long back focal length, amending the aberration outside a shaft good by limiting the power of the 1st group lens G1, and making it a lens not become large beyond the need. Since the negative refractive power of the 1st group lens G1 will become weak too much and the configuration of a retro focus mold will become weak if an upper limit is exceeded, it becomes difficult to secure long back focal length, and the dimension of the 1st group lens G1 becomes large beyond the need. Moreover, if a minimum is exceeded, the negative refractive power of the 1st group lens G1 will become large too much, and amendment of the aberration outside a shaft

will become difficult.
[0031] Conditional expression (3) and (4) moreover, by restricting small the shaft top power of the 1st lens L1 which consists of plastic material, and the 12th lens L12 If it is the conditional expression for extending the operating temperature limits of the retro focus mold lens 10, and preventing the focal gap to a temperature change and the power of the 1st lens L1 and the 12th lens L12 becomes large exceeding the minimum of each formula It becomes [resolution change and a focal gap / too much] large to environmental temperature change for which the retro focus mold lens 10 is used and is inconvenient.
[0032] moreover — from the image surface by the side of small conjugation [in / for |EXP| / the lens whole system] while stopping down the retro focus mold lens 10 to the gestalten 1-5 of operation between the 2nd group lens G2 and 3rd group lens G3 and having STO — this — small — the time of considering as the absolute value of the distance to the pupil surface by the side of **** conjugation — the following conditional expression (5)
| EXP|/f > 50 — (5)
It is constituted so that it may be satisfied.
[0033] In the retro focus mold lens 10 with which are satisfied of conditional expression (5), since the chief ray of the flux of light from each image quantity which carries out incidence to a projection lens from a light valve can be done in abbreviation parallel to an optical axis, the bad influence to the projection image which can secure a high ambient light quantitative ratio, and originates in the optical property change by the incident angle property of Prism PSM can be lost. If the distance between the pupil surface by the side of small conjugation and the image surface by the side of small conjugation becomes small exceeding the minimum of conditional expression (5), the inclination of the chief ray by the side of a light valve becomes large too much and is inconvenient.
[0034] Moreover, the retro focus mold lens 10 to the gestalten 1-5 of operation is the following conditional expression (6), when BFL is made into the back focal length of the lens whole system.
BFL/f > 2 — (6)
It is constituted so that it may be satisfied.
[0035] In the retro focus mold lens with which are satisfied of conditional expression (6), it is possible to secure the long back focal length who can arrange the cover glass CG which protects Prism PSM and a light valve between a projection lens and a light valve, and suitable air spacing in spite of an extensive field angle and a short focal distance. If back focal length becomes small exceeding the minimum of conditional expression (6), it will become inconvenient, when arranging the thick prism PSM, cover glass CG, etc.
[0036] Moreover, the retro focus mold lens 10 to the gestalten 1-5 of operation The Abbe number in d line of the ** material which constitutes the 4th lens L4 for nu 4, the Abbe number in d line of the ** material which constitutes the 5th lens L5 for nu 5, The Abbe number in d line of the ** material which constitutes the 7th lens L7 for nu 7, the Abbe number in d line of the ** material which constitutes the 8th lens L8 for nu 8, (11) 11 [the following conditional expression (7), (8), (9), (10), and] When the Abbe number in d line of the ** material which constitutes the 9th lens L9 for nu 9, and nu 10 are made into the Abbe number in d line of the ** material which constitutes the 10th lens L10, reach (12).
15 — < — nu 4 <30 — (7)
15 — < — nu 5 <30 — (8)
40 — < — nu 7 <100 — (9)
15 — < — nu 8 <32 — (10)
20 — < — nu 9 <50 — (11)
70 — < — nu10<100 — (12)
It is constituted so that it may be satisfied.
[0037] In the retro focus mold lens 10 with which are satisfied of from conditional expression (7) to (12), it is restricting respectively the Abbe number of the 4th lens L4, the 5th lens L5, the 7th lens L7, the

8th lens L8, the 9th lens L9, and the 10th lens L10 to the predetermined range, and is appropriately controllable in axial overtone aberration and the chromatic aberration of magnification. If the Abbe number of the ** material which constitutes each lenses L4, L5, L7, L8, L9, and L10 is set up exceeding the upper limit or minimum of each formula, the absolute value of axial overtone aberration and the chromatic aberration of magnification and the chromatic-aberration amendment balance between R/G/B each primary color will collapse, and the lack of resolution of the specific primary color by the increment in axial overtone aberration and a pixel gap of the specific primary color by the increment in the chromatic aberration of magnification will pose a problem.

[0038] Moreover, the retro focus mold lens 10 to the gestalten 1-5 of operation In the system of coordinates which considered as the parameter showing the anomalous-scattering nature of the ** material which constitutes the m-th lens (m= 4, 5, 8, 10) for dPgFm, and took the partial dispersion ratio PgF from an F line to g line for Abbe number nud in d line along the axis of ordinate for the axis of abscissa When PgFma (nud) shows the abnormality partial dispersion ratio of the ** material which shows the straight line (ABBE line) showing a normal partial dispersion ratio by PgFn (nud), and shows the anomalous-scattering nature which constitutes the m-th lens in Abbe number nud in d line, it is dPgFm=PgFma(nud)-PgFn (nud).

(15) 15 [the following conditional expression (13) (14), and] Come out, be and reach (16).

0.008<dPgF4 <0.03 — (13)

0.01 <DPgF5 <0.025 — (14)

0.01 <DPgF8 <0.02 — (15)

0.03 <DPgF 10< 0.055 — (16)

It is satisfied.

[0039] In addition, it is PgF=(ng-nF)/(nF-nC) and ng, nF, and nC express the refractive index in the wavelength of g line (wavelength of 435.8nm), an F line (wavelength of 486.1nm), and C line (wavelength of 656.3nm), respectively. Moreover, the ABBE line used here is a line which plots two points which show two kinds of normal partial-dispersion glass, and connects these two points in the system of coordinates to which the partial dispersion ratio PgF was taken along the axis of ordinate, and it took Abbe number nud along the axis of abscissa. Although an ABBE line changes a little with glass manufacturers, it shows the in general same value. By (d), the ABBE line in a shot company (SCHOTT), Ohara Inc. (OHARA), Hoya Corp. (Hoya), and Sumita Optical Glass, Inc. (SUMITA) is shown from drawing 12 (a). An ABBE line can be expressed with the following primary functions so that it may be shown by (d) from drawing 12 (a).

shot company :P. d+gF=-0.001689*nu0.644224 Ohara :P. gF=-0.001618*nud+0.641462Hoya :P. gF=-0.001802*nud+0.648327 Sumita Optical Glass :P gF=-0.001488*nud+0.637000 — since an ABBE line shows the in general same value in this way, dPgFm should just fill from the above-mentioned conditional expression (13) to (16) about one of the ABBE lines shown in drawing 12 .

[0040] Especially the flare component of short wavelength can be effectively decreased with restricting respectively the anomalous-scattering nature of the ** material which therefore constitutes the 4th lens L4, the 5th lens L5, the 8th lens L8, and the 10th lens L10 from above-mentioned conditional expression (7) from conditional expression (13) to (16) in addition to the effectiveness of the chromatic-aberration amendment by the conditions to (12) to the predetermined range. For example, although the bright line spectrum near the g line of mercury is contained in the illumination light when an extra-high pressure mercury lamp is used for the light source, according to the retro focus mold lens 10 to the gestalten 1-5 of operation, the flare component of the projection image which this bright line spectrum becomes a cause and generates can be controlled effectively. Consequently, when a fine alphabetic character and a fine line are included in a projection image, the feeling of resolving of a display image can deteriorate by the flare component of a purple-blue color, or the problem recognized as an image with NIJIMI can be solved. On the contrary, when the anomalous-scattering nature of each above-mentioned lens is selected from conditional expression (13) exceeding the upper limit or minimum to (16),

the flare component of a purple-blue color will increase and high definition nature will be spoiled.
[0041] Conditional expression [following] (17) Moreover, the retro focus mold lens 10 to the gestalten 1-5 of operation reaches (18).
$-0.01 < dPgF\ 7 < 0.045$ — (17)
$-0.015 < dPgF\ 9 < 0.02$ — (18)
It is satisfied.
[0042] It becomes possible with restricting respectively the anomalous-scattering nature of the 7th lens L7 and the 9th lens L9 to the predetermined range by conditional expression (17) and (18) in addition to the aberration amendment from conditional expression (13) to (16), and flare depressor effect to control the flare component of a projection image still more finely. Consequently, when a fine alphabetic character and a fine line are included in a projection image, the feeling of resolving of a display image can deteriorate by the flare component of a purple-blue color, or the problem recognized as an image with NIJIMI can be solved. On the contrary, when the anomalous-scattering nature of each above-mentioned lens is set up exceeding conditional expression (17) and the upper limit of (18), or a minimum, the flare component of a purple-blue color will increase and high definition nature will be spoiled.
[0043] Each element which constitutes the retro focus mold lens 10 of the gestalt 1 of gestalt 1 implementation of operation is specified by the numerical example shown in the following table 1. In Table 1, S1-S23 show each side of lenses L1-L12. Moreover, S24 and S25 show each side of Prism PSM, and S26 and S27 show each side of cover glass CG. Moreover, the refractive index of ** material [as opposed to / OBJ / R / a screen and / as opposed to / in the radius of curvature of each side and T / the spacing of each field / d line (it is d line of helium and is 587.56nm in wavelength) in Nd], an Abbe number [in / in nud / d line], and Infinity show infinity. Moreover, Type shows the type of a special field, ASP shows the aspheric surface and STO shows a diaphragm side.
[0044]
[Table 1]

S	R	T	Nd	νd	Type
OBJ	Infinity	858.55			
1	-523.6556	4	1.491000	57.562	ASP
2	514.0728	0.5304008			ASP
3	33.83429	5.479604	1.816000	46.600	
4	18.11977	7.402664			
5	60.944	1.930828	1.516800	64.200	
6	29.00685	5.523577			
7	-62.45322	15.25701	1.915357	21.200	
8	-694.9453	30.34551			
9	26.82546	3.041943	1.846659	23.800	
10	-365.2097	1.68066	1.806100	40.730	
11	257.9009	0.2485364			
12	Infinity	10.12673			STO
13	-42.11169	6.136205	1.668921	45.000	
14	-23.92971	1.092819			
15	-18.54591	1.508804	1.846660	23.830	
16	18.54591	4.072995	1.797120	35.080	
17	234.3953	2.943065			
18	35.36946	6.982814	1.434250	95.000	
19	-37.2984	0.8544881			
20	37.99807	6.120832	1.516800	64.200	
21	-123.2559	0.4768649			
22	83.18422	3.34	1.491000	57.562	ASP
23	-137.8496	5.03			ASP
24	Infinity	26	1.516800	64.200	
25	Infinity	3			
26	Infinity	2.74	1.471693	65.850	
27	Infinity				

[0045] Moreover, the 1st lens L1 consists of plastic material (PMMA:polymethylmethacryl ate), and makes the aspheric surface the lens sides S1 and S2. Moreover, the 12th lens L12 also consists of the same PMMA, and makes the aspheric surface the lens sides S22 and S23. The configuration of the lens sides S1 and S2 and the lens sides S22 and S23 is expressed with a degree type (19).

[0046]

[Equation 1]

$$Z=\frac{Y^2/R}{1+\{1-(1+K)Y^2/R^2\}^{\frac{1}{2}}}+DY^4+EY^6+FY^8+GY^{10}+HY^{12}+IY^{14}$$

…式（１９）

[0047] the distance of the direction of the optical axis [here / Z] on the basis of the top-most vertices of a lens side, and Y — the distance to a direction perpendicular to an optical axis, and K — a conic multiplier and R — core radius of curvature and D — in the 4th aspheric surface multiplier and E, the 10th aspheric surface multiplier and H show the 12th aspheric surface multiplier, and, as for the 6th aspheric surface multiplier and F, I shows the 14th aspheric surface multiplier, as for the 8th aspheric surface multiplier and G. Moreover, the value of the aspheric surface multipliers K, D, E, F, G, H, and I is shown in the following table 2.

[0048]

[Table 2]

<非球面係数>

S	K	D	E	F
1	32.79982	3.5020967e-5	-8.659474e-8	1.2542213e-10
2	-3.143952	3.8128909e-5	-1.3036009e-7	2.3490044e-10
22	-96.65446	1.8810461e-6	-1.372124e-7	-1.4116834e-10
23	-2.165457	3.4512883e-6	-3.2416442e-8	-4.9537585e-10

S	G	H	I
1	-6.6214841e-14	-1.0583201e-17	2.1834647e-20
2	-1.595244e-13	-2.3343029e-18	3.3386459e-20
22	2.6262719e-12	-9.9308871e-15	1.4447615e-17
23	3.3877491e-12	-9.6148395e-15	1.1066089e-17

[0049] Since the 1st lens L1 and the 12th lens L12 were formed with plastic material and it considered as the aspheric lens, the various aberration outside a shaft can be amended good in spherical aberration, distortion aberration, and a list. Moreover, as shown in the above-mentioned conditional expression (3) and (4), also when focal gap when a temperature change arises is small controlled by setting up greatly the shaft top focal distance of each plastic lens to the focal distance of all lens systems and the temperature of an operating environment changes by it, change of the image formation optical property centering on the resolution of all lens systems can be made small.

[0050] In addition, OZ-1000 (trade name) by ingredients by Nippon Zeon Co., Ltd. other than PMMA, for example, ZEONEX-280S (trade name) and Hitachi Chemical Co., Ltd., may be used for the plastic material of the 1st lens L1 and the 12th lens L12, and it can raise the upper limit of the operating temperature limits as the lens whole system in this case.

[0051] The diaphragm STO shown in drawing 1 and Table 1 adjusts the brightness of a projection image, and the balance of resolving power with regards to the chief ray inclination by the side of a light valve. For example, in the equipment of drawing 13 , when the flux of light 20 modulated with the light valve is infinite and parallel to the optical axis of a lens, even if it extracts by the tele cent rucksack nature of the projection lens 7 and makes the diameter of opening of S12 small, sufficient brightness can be

obtained. The illumination-light bundle 2 has a certain angular distribution, and the light valve side is illuminated, and when the diameter of opening of Diaphragm STO is made not much small, it becomes impossible however, to obtain the brightness of enough projection images in fact. On the contrary, when the diameter of opening of Diaphragm STO tends to be enlarged and it is going to secure brightness, there is a possibility that the beam of light which carries out incidence with the include angle which is in a light valve side for the tele cent rucksack nature of a lens may spoil resolution. Therefore, as for Diaphragm STO, it is desirable to consider as a configuration in which the diameter of opening is changed into arbitration with the combination of an illumination system and a lens.

[0052] Moreover, f2/f3 in the retro focus mold lens 10 of the gestalt 1 of operation, |f1|/f, |f4| / f5 [f and]/f, |EXP|/f, and BFL/f It becomes the value shown in Table 11 mentioned later, and nu4, nu5, nu7, nu8, nu9, nu10, dPgF4, dPgF5, dPgF7, dPgF8, dPgF9, and dPgF10 become the value shown in Table 12 mentioned later, and above-mentioned conditional-expression (1) - (18) is satisfied. Moreover, the part number (GLASS column) of the dPgF value of the 4th lens L4, the 5th lens L5, the 7th lens L7, the 8th lens L8, the 9th lens L9, and the 10th lens L10, the manufacture name which manufactured this, and ** material is shown in Table 13.

[0053] Furthermore, the retro focus mold lens 10 of the gestalt 1 of operation has long back focal length so that air spacing suitable in the optical path from the retro focus mold lens 10 to [can arrange Prism PSM and the cover glass CG of the front face of a light valve between the retro focus mold lens 10 and a light valve side, and] the image formation side IMG of a light valve can be arranged. Moreover, the chief ray in each field angle is designed so that it may become abbreviation parallel to a lens optical axis by the light valve side, and since transparency within prism and reflection become uniform in a screen while securing sufficient amount of ambient light, it can mitigate the generating factor of the color nonuniformity of a projection image, and brightness nonuniformity.

[0054] Drawing 2 shows the property of the retro focus mold lens of the gestalt 1 of operation, and the astigmatism [drawing / this / (a)] by the side of small conjugation and this drawing (b) show distortion aberration. Both the astigmatism and distortion aberration that are shown in drawing 2 are plotted about light with a wavelength of 546.1nm. Moreover, in drawing 2 (a), TAs are a chief ray besides a shaft, and a tangential beam of light which is a beam of light within a field including an optical axis, and SA is a SAJITTARU beam of light which is a beam of light which intersects perpendicularly with a tangential plane including the chief ray besides a shaft.

[0055] Drawing 3 shows the property of the retro focus mold lens of the gestalt 1 of operation, and, as for this drawing (a), image quantity shows 10.24mm (screen side field angle of 40.8 degrees) transverse aberration, as for the transverse aberration on a shaft (that is, image quantity 0.00mm), and this drawing (b). Moreover, in this drawing, PY shows Y shaft orientations perpendicular to an optical axis, and EY shows the transverse aberration of Y shaft orientations. Moreover, PX shows X shaft orientations perpendicular to an optical axis and a Y-axis, and EX shows the transverse aberration of X shaft orientations. Moreover, transverse aberration was plotted about the light of wavelength WL1 (= 470nm), wavelength WL2 (= 546.1nm), and wavelength WL3 (= 610nm).

[0056] In the projection mold display using the light valve which has matrix-like pixel array structure, since no means other than a lens can amend distortion of the color gap and the projection screen covering the whole screen, size, such as chromatic aberration of a lens and distortion aberration, influences the quality of a projection image greatly as it is. With the retro focus mold lens of the gestalt 1 of operation said conditional expression (7), (8), (9), (10), (11), and (12) — lenses L4, L5, L7, L8, L9, and L10 — with restricting the upper limit and lower limit of each Abbe number The chromatic aberration (axial overtone aberration and chromatic aberration of magnification) of all lens systems can be controlled small, and color gap of the primary color pixel of a projection image can be suppressed to less than 7 micrometers and a small value to the chief ray on a light valve side.

[0057] conditional expression (13), (14), (15), and (16) — setting — lenses L4, L5, L8, and L10 — with restricting the upper limit and lower limit of each anomalous-scattering nature [furthermore,] For

example, it becomes possible to control the flare component of the projection image resulting from the bright line spectrum near the g line of the mercury contained in the light valve illumination light when an extra-high pressure mercury lamp is used for the light source. When a fine alphabetic character and a fine line are included in a projection image, the feeling of resolving of a display image can deteriorate by the flare component of a purple-blue color (Violet), or the problem recognized as an image with NIJIMI can be solved. This flare depressor effect acts much more effectively with restricting the upper limit and lower limit of a lens L7, a lens L9, and each anomalous-scattering nature by conditional expression (17) and (18) further.

[0058] As explained above, in the retro focus mold lens 10 of the gestalt 1 of operation, chromatic aberration (vertical chromatic aberration, the chromatic aberration of magnification, flare component) and distortion aberration are fully amended, and sufficient projection engine performance can be realized on the occasion of the use as a rear projector. Furthermore, other shaft top aberration and the various aberration outside a shaft are also fully amended so that projection of the light valve of the many pixels of 1 million-pixel class may be possible.

[0059] The configuration of the retro focus mold lens 10 in the gestalt 2 of gestalt 2 implementation of operation is specified by the numerical example shown in the following table 3.

[0060]

[Table 3]

S	R	T	Nd	νd	Type
OBJ	Infinity	858.55			
1	-523.6556	4	1.491000	57.562	ASP
2	514.0728	0.3460913			ASP
3	32.46232	6.741718	1.815500	44.540	
4	17.70302	7.509995			
5	61.35029	1.513102	1.516800	64.200	
6	28.64692	5.370549			
7	-62.80119	15.68162	1.952500	20.360	
8	-591.8352	29.28073			
9	27.42022	2.96639	1.846660	23.780	
10	523.2012	1.640253	1.835000	42.980	
11	239.0524	0.4799632			
12	Infinity	10.7825			STO
13	-36.80036	8.578273	1.670030	47.110	
14	-21.68061	0.8112146			
15	-17.80312	1.499474	1.806450	24.400	
16	17.80312	5.136428	1.803490	30.400	
17	166.289	0.7903997			
18	36.07789	7.570944	1.455999	90.300	
19	-37.86468	0.4496936			
20	37.05455	5.229943	1.516800	64.200	
21	-124.2783	0.3900116			
22	83.18422	3.34	1.491000	57.562	ASP
23	-137.8496	5.03			ASP
24	Infinity	26	1.516800	64.200	
25	Infinity	3			
26	Infinity	2.74	1.471693	65.850	
27	Infinity				

[0061] The configuration of the lens sides S1 and S2 and the lens sides S22 and S23 is expressed with the above-mentioned formula (19). Moreover, the value of the aspheric surface multipliers K, D, E, F, G, H, and I is shown in the following table 4.

[0062]

[Table 4]

<非球面係数>

S	K	D	E	F
1	32.79982	3.5020967e-5	-8.659474e-8	1.2542213e-10
2	-3.143952	3.8128909e-5	-1.3036009e-7	2.3490044e-10
22	-96.65446	1.8810461e-6	-1.372124e-7	-1.4116834e-10
23	-2.165457	3.4512883e-6	-3.2416442e-8	-4.9537585e-10

S	G	H	I
1	-6.6214841e-14	-1.0583201e-17	2.1834647e-20
2	-1.695244e-13	-2.3343029e-18	3.3386459e-20
22	2.6262719e-12	-9.9308871e-15	1.4447615e-17
23	3.3877491e-12	-9.6148395e-15	1.1066089e-17

[0063] Moreover, f2/f3 in the retro focus mold lens 10 of the gestalt 2 of operation, |f1|/f, |f4| / f5 [f and]/f, |EXP|/f, and BFL/f It becomes the value shown in Table 11 mentioned later, and nu4, nu5, nu7, nu8, nu9, nu10, dPgF4, dPgF5, dPgF7, dPgF8, dPgF9, and dPgF10 become the value shown in Table 12 mentioned later, and above-mentioned conditional-expression (1) - (18) is satisfied. Moreover, the part number (GLASS column) of the dPgF value of the 4th lens L4, the 5th lens L5, the 7th lens L7, the 8th lens L8, the 9th lens L9, and the 10th lens L10, the manufacture name which manufactured this, and ** material is shown in Table 14.

[0064] Drawing 4 shows the property of the retro focus mold lens of the gestalt 2 of operation, and the astigmatism [drawing / this / (a)] by the side of small conjugation and this drawing (b) show distortion aberration. Both the astigmatism and distortion aberration that are shown in drawing 4 are plotted about light with a wavelength of 546.1nm.

[0065] Drawing 5 shows the property of the retro focus mold lens of the gestalt 2 of operation, and, as for this drawing (a), image quantity shows 10.24mm (screen side field angle of 40.8 degrees) transverse aberration, as for the transverse aberration on a shaft (that is, image quantity 0.00mm), and this drawing (b). Transverse aberration was plotted about the light of wavelength WL1 (= 470nm), wavelength WL2 (= 546.1nm), and wavelength WL3 (= 610nm). In addition, in the gestalt 2 of operation, points other than the above are the same as the gestalt 1 of the above-mentioned implementation.

[0066] The configuration of the retro focus mold lens 10 in the gestalt 3 of gestalt 3 implementation of operation is specified by the numerical example shown in the following table 5.

[0067]

[Table 5]

S	R	T	Nd	νd	Type
OBJ	Infinity	858.55			
1	-623.6556	4	1.491000	57.562	ASP
2	514.0728	0.290537			ASP
3	35.40269	6.328004	1.815500	44.540	
4	17.97651	9.225756			
5	732.3459	1.511957	1.565800	61.000	
6	39.71425	4.475727			
7	-61.05018	17.00026	1.846660	23.830	
8	-88.2142	25.28463			
9	31.6968	7.644573	1.806450	24.400	
10	-56.61138	1.525936	1.850259	32.300	
11	400.5343	0.2472514			
12	Infinity	6.278201			STO
13	-45.30646	7.217561	1.668921	45.000	
14	-29.10246	1.844334			
15	-22.93409	1.499244	1.806450	24.400	
16	22.93409	5.404707	1.880670	41.010	
17	84.79871	3.100244			
18	35.30042	6.928448	1.438750	95.000	
19	-39.75226	0.3045151			
20	38.59989	5.269955	1.565800	61.000	
21	-120.6387	0.4012553			
22	83.18422	3.34	1.491000	57.562	ASP
23	-137.8496	5.03			ASP
24	Infinity	26	1.516800	64.200	
25	Infinity	3			
26	Infinity	2.74	1.471693	65.850	
27	Infinity				

[0068] The configuration of the lens sides S1 and S2 and the lens sides S22 and S23 is expressed with the above-mentioned formula (19). Moreover, the value of the aspheric surface multipliers K, D, E, F, G, H, and I is shown in the following table 6.

[0069]

[Table 6]

<非球面係数>

S	K	D	E	F
1	32.79982	3.5020967e-5	-8.659474e-8	1.2542213e-10
2	-3.143952	3.8128909e-5	-1.3036009e-7	2.3490044e-10
22	-96.65446	1.8810461e-6	-1.372124e-7	-1.4116834e-10
23	-2.165457	3.4512883e-6	-3.2416442e-8	-4.9537585e-10

S	G	H	I
1	-6.6214841e-14	-1.0583201e-17	2.1834647e-20
2	-1.595244e-13	-2.3343029e-18	3.3386459e-20
22	2.6262719e-12	-9.9308871e-15	1.4447615e-17
23	3.3877491e-12	-9.6148395e-15	1.1066089e-17

[0070] Moreover, f2/f3 in the retro focus mold lens 10 of the gestalt 3 of operation, |f1|/f, |f4| / f5 [f and]/f, |EXP|/f, and BFL/f It becomes the value shown in Table 11 mentioned later, and nu4, nu5, nu7, nu8, nu9, nu10, dPgF4, dPgF5, dPgF7, dPgF8, dPgF9, and dPgF10 become the value shown in Table 12 mentioned later, and above-mentioned conditional-expression (1) - (18) is satisfied. Moreover, the part number (GLASS column) of the dPgF value of the 4th lens L4, the 5th lens L5, the 7th lens L7, the 8th lens L8, the 9th lens L9, and the 10th lens L10, the manufacture name which manufactured this, and ** material is shown in Table 15.

[0071] Next, the astigmatism by the side of small conjugation of this lens system and distortion aberration are shown in drawing 6 , and transverse aberration is shown in drawing 7 . Astigmatism and distortion aberration were plotted about the wavelength of 546.1nm. Moreover, transverse aberration was plotted about the wavelength WL3 with a wavelength [WL / 1,546.1 nm] of 470nm of wavelength WL2,610nm. Drawing 7 (a) is the transverse aberration on a shaft, and drawing 7 (b) is the transverse aberration of the 10.24mm of the maximum image quantities (screen side field angle of 40.8 degrees). In addition, in the gestalt 3 of operation, points other than the above are the same as the gestalt 1 of the above-mentioned implementation.

[0072] The configuration of the retro focus mold lens 10 which can set gestalt 4 implementation of operation gestalt 4 is specified by the numerical example shown in the following table 7.

[0073]

[Table 7]

S	R	T	Nd	νd	Type
OBJ	Infinity	858.55			
1	-523.6556	4	1.491000	57.562	ASP
2	514.0728	0.3106203			ASP
3	32.11425	4.897889	1.815500	44.540	
4	18.13915	9.891571			
5	615.953	1.867131	1.516800	64.200	
6	38.07008	4.872353			
7	-55.8922	10.76093	1.952500	20.360	
8	-158.9936	33.43624			
9	27.15409	1.71539	1.846660	23.780	
10	65.88343	1.703782	1.835000	42.980	
11	389.4769	1.885492			
12	Infinity	10.1411			STO
13	-34.59501	7.346158	1.434250	95.000	
14	-20.98952	1.303026			
15	-16.54598	1.698124	1.806450	24.400	
16	16.54598	5.182819	1.784696	26.300	
17	173.9901	0.2414552			
18	35.77961	8.228911	1.455999	90.300	
19	-29.56398	0.734205			
20	38.65487	5.236639	1.516800	64.200	
21	-96.22279	0.312764			ASP
22	83.18422	3.34	1.491000	57.562	ASP
23	-137.8496	5.03			ASP
24	Infinity	26	1.516800	64.200	
25	Infinity	3			
26	Infinity	2.74	1.471693	65.850	
27	Infinity				

[0074] The configuration of the lens sides S1 and S2 and the lens sides S22 and S23 is expressed with

the above-mentioned formula (19). Moreover, the value of the aspheric surface multipliers K, D, E, F, G, H, and I is shown in the following table 8.

[0075]

[Table 8]

<非球面係数>

S	K	D	E	F
1	32.79982	3.5020967e-5	-8.659474e-8	1.2542213e-10
2	-3.143952	3.8128909e-6	-1.3036009e-7	2.3490044e-10
21	5.656857	5.7780988e-8	5.0172158e-9	5.67066e-12
22	-96.65446	1.8810461e-6	-1.372124e-7	-1.4116834e-10
23	-2.165457	3.4512883e-6	-3.2416442e-8	-4.9537585e-10

S	G	H	I
1	-6.6214841e-14	-1.0583201e-17	2.1834647e-20
2	-1.595244e-13	-2.3343029e-18	3.3386459e-20
21	1.4116746e-14	0.00	0.00
22	2.6262719e-12	-9.9308871e-15	1.4447615e-17
23	3.3877491e-12	-9.6148395e-15	1.1066089e-17

[0076] Moreover, f2/f3 in the retro focus mold lens 10 of the gestalt 4 of operation, |f1|/f, |f4| / f5 [f and]/f, |EXP|/f, and BFL/f It becomes the value shown in Table 11 mentioned later, and nu4, nu5, nu7, nu8, nu9, nu10, dPgF4, dPgF5, dPgF7, dPgF8, dPgF9, and dPgF10 become the value shown in Table 12 mentioned later, and above-mentioned conditional-expression (1) - (18) is satisfied. Moreover, the part number (GLASS column) of the dPgF value of the 4th lens L4, the 5th lens L5, the 7th lens L7, the 8th lens L8, the 9th lens L9, and the 10th lens L10, the manufacture name which manufactured this, and ** material is shown in Table 16.

[0077] Next, the astigmatism by the side of small conjugation of this lens system and distortion aberration are shown in drawing 8 , and transverse aberration is shown in drawing 9 . Astigmatism and distortion aberration were plotted about the wavelength of 546.1nm. Moreover, transverse aberration was plotted about the wavelength WL3 with a wavelength [WL / 1,546.1 nm] of 470nm of wavelength WL2,610nm. Drawing 9 (a) is the transverse aberration on a shaft, and drawing 9 (b) is the transverse aberration of the 10.24mm of the maximum image quantities (screen side field angle of 40.7 degrees). In addition, in the gestalt 4 of operation, points other than the above are the same as the gestalt 1 of the above-mentioned implementation.

[0078] The configuration of the retro focus mold lens 10 in the gestalt 5 of gestalt 5 implementation of operation is specified by the numerical example shown in the following table 9.

[0079]

[Table 9]

S	R	T	Nd	νd	Type
OBJ	Infinity	858.55			
1	-523.6556	4	1.491000	57.562379	ASP
2	514.0728	0.2507191			ASP
3	31.79713	5.83051	1.816600	44.540001	
4	17.41408	8.94829			
5	250.0999	1.500401	1.518206	65.000000	
6	32.69828	5.044313			
7	-50.54402	17.00136	1.808095	22.800000	
8	-116.8878	28.05658			
9	27.78104	2.077707	1.784700	26.100000	
10	-379.0815	1.499639	1.822230	37.450001	
11	192.1694	1.933463			
12	Infinity	13.95595			STO
13	-33.44034	1.499981	1.670030	47.110001	
14	-17.82397	0.4832298			
15	-15.78343	1.498544	1.806450	24.400000	
16	15.78343	5.389283	1.784723	25.700000	
17	188.8437	0.2447158			
18	35.68195	6.9571	1.455999	90.300000	
19	-31.56879	3.626223			
20	33.3398	5.424156	1.518350	60.300000	
21	-157.8581	0.5667947			
22	83.18422	3.34	1.491000	57.562379	ASP
23	-137.8496	5.03			ASP
24	Infinity	26	1.516800	64.199997	
25	Infinity	3			
26	Infinity	2.74	1.471693	65.849544	
27	Infinity				

[0080] The configuration of the lens sides S1 and S2 and the lens sides S22 and S23 is expressed with the above-mentioned formula (19). Moreover, the value of the aspheric surface multipliers K, D, E, F, G, H, and I is shown in the following table 10.

[0081]

[Table 10]

<非球面係数>

S	K	D	E	F
1	32.79982	3.5020967e-5	-8.659474e-8	1.2542213e-10
2	-3.143952	3.8128909e-5	-1.3036009e-7	2.3490044e-10
22	-96.65446	1.8810461e-6	-1.372124e-7	-1.4116834e-10
23	-2.165457	3.4512883e-6	-3.2416442e-8	-4.9537585e-10

S	G	H	I
1	-6.6214841e-14	-1.0583201e-17	2.1834647e-20
2	-1.595244e-13	-2.3343029e-18	3.3386459e-20
22	2.6262719e-12	-9.9308871e-15	1.4447615e-17
23	3.3877491e-12	-9.6148395e-15	1.1066089e-17

[0082] Moreover, f2/f3 in the retro focus mold lens 10 of the gestalt 5 of operation, |f1|/f, |f4| / f5 [f and]/f, |EXP|/f, and BFL/f It becomes the value shown in Table 11 mentioned later, and nu4, nu5, nu7, nu8, nu9, nu10, dPgF4, dPgF5, dPgF7, dPgF8, dPgF9, and dPgF10 become the value shown in Table 12 mentioned later, and above-mentioned conditional-expression (1) - (18) is satisfied. Moreover, the part number (GLASS column) of the dPgF value of the 4th lens L4, the 5th lens L5, the 7th lens L7, the 8th lens L8, the 9th lens L9, and the 10th lens L10, the manufacture name which manufactured this, and ** material is shown in Table 17.

[0083] Next, the astigmatism by the side of small conjugation of this lens system and distortion aberration are shown in drawing 10 , and transverse aberration is shown in drawing 11 . Astigmatism and distortion aberration were plotted about the wavelength of 546.1nm. Moreover, transverse aberration was plotted about the wavelength WL3 with a wavelength [WL / 1,546.1 nm] of 470nm of wavelength WL2,610nm. Drawing 11 (a) is the transverse aberration on a shaft, and drawing 11 (b) is the transverse aberration of the 10.24mm of the maximum image quantities (screen side field angle of 40.8 degrees). In addition, in the gestalt 5 of operation, points other than the above are the same as the gestalt 1 of the above-mentioned implementation.

[0084] If the various parameters of a numerical example (Tables 1-5) explained with the gestalten 1-5 of the above-mentioned implementation are packed, it will become as it is shown in the following tables 11-17.

[0085]

[Table 11]

実施の形態	f(mm)	ω(deg)	F	β	f1	f2	f3	EXP	|f1|/f	f5	BFL	|f1|/f	f2/f3	|f4|/f	f5/f	|EXP|/f	BFL/f
1	11.79	40.8	3.0	-76.3	21.33	34.36	35.05	-1331.6	5.35	105.8	28.40	1.8	1.0	44.6	9.0	113.0	2.4
2	11.79	40.8	3.0	-76.3	21.43	35.43	34.19	-1669.9	5.28	105.8	28.39	1.8	1.0	44.6	9.0	133.3	2.4
3	11.79	40.8	3.0	-76.3	26.83	43.18	30.72	-835.4	5.35	105.8	28.38	2.3	1.4	44.6	9.0	70.2	2.4
4	11.84	40.7	3.0	-76.0	21.64	34.21	35.47	-1858.1	5.35	105.8	28.40	1.8	1.0	44.4	8.9	161.5	2.4
5	11.79	40.8	3.0	-76.4	23.05	41.07	34.28	-1954.7	5.35	105.8	28.39	2.0	1.2	44.7	9.0	165.8	2.4

[0086]

[Table 12]

実施の形態	ν4	ν5	ν7	ν8	ν9	ν10	dPgF4	dPgF5	dPgF7	dPgF8	dPgF9	dPgF10
1	21.20	23.80	45.00	23.83	35.08	95.00	0.0220	0.0181	0.0005	0.0123	0.0011	0.0385
2	20.36	23.78	47.11	24.40	30.40	90.30	0.0217	0.0136	-0.0001	0.0136	0.0055	0.0386
3	23.83	24.40	45.00	24.40	41.01	95.00	0.0123	0.0136	0.0005	0.0136	-0.0084	0.0463
4	20.36	23.78	95.00	24.40	26.30	90.30	0.0217	0.0136	0.0385	0.0136	0.0146	0.0386
5	22.80	26.10	47.11	24.40	25.70	90.30	0.0251	0.0142	-0.0001	0.0136	0.0162	0.0386

[0087]

[Table 13]

<実施の形態１>

	Glass	dPgF	硝材メーカ
L4	PBH72	0.022	OHARA
L5	TIH53	0.0181	OHARA
L7	BAH13	0.0005	OHARA
L8	SF57	0.0123	SCHOTT
L9	LASF36A	0.0011	SCHOTT
L10	CAFK95	0.0385	SUMITA

[0088]

[Table 14]

<実施の形態２>

	Glass	dPgF	硝材メーカ
L4	SF59	0.0217	SCHOTT
L5	FDS90	0.0136	HOYA
L7	BAFN10	-0.0001	SCHOTT
L8	SFLD60	0.0136	SUMITA
L9	LASF32	0.0055	SCHOTT
L10	S-FPL52	0.0386	OHARA

[0089]

[Table 15]

<実施の形態３>

	Glass	dPgF	硝材メーカ
L4	SF57	0.0123	SCHOTT
L5	SFLD60	0.0136	SUMITA
L7	BAH13	0.0005	OHARA
L8	SFLD60	0.0136	SUMITA
L9	LASFN31	-0.0084	SCHOTT
L10	SFPL53	0.0463	OHARA

[0090]

[Table 16]

<実施の形態４>

	Glass	dPgF	硝材メーカ
L4	SF59	0.0217	SCHOTT
L5	FDS90	0.0136	HOYA
L7	CAFK95	0.0385	SUMITA
L8	SFLD60	0.0136	SUMITA
L9	STIH23	0.0146	OHARA
L10	SFPL52	0.0386	OHARA

[0091]

[Table 17]

<実施の形態５>

	Glass	dPgF	硝材メーカ
L4	S-NPH1	0.0261	OHARA
L5	FDS30	0.0142	HOYA
L7	BAFN10	-0.0001	SCHOTT
L8	SFLD60	0.0136	SUMITA
L9	S-TIH11	0.0162	OHARA
L10	S-FPL52	0.0386	OHARA

[0092] In a table, an effective F value [in / f / the focal distance of the lens whole system and omega, and / in F / a criteria projection scale factor] (small conjugation side) and beta show a criteria projection scale factor. [a projection half field angle (big conjugation side)] Moreover, in f1, the focal distance of 3rd group lens G3 and f4 show the shaft top focal distance of the 1st lens L1 of the aspheric surface, and, as for the focal distance of the 1st group lens G1, and f2, f5 shows the shaft top

focal distance of the 12th lens L12 of the aspheric surface, as for the focal distance of the 2nd group lens G2, and f3. moreover — from the image surface by the side of small conjugation [in / in EXP / the lens whole system] — this — small — the distance to the pupil surface by the side of **** conjugation and BFL show the back focal length of the lens whole system (when a big conjugation side is made into infinite distance incidence except for Prism PSM and cover glass CG). In addition, the whole of each parameter of Table 11 is a value in the wavelength of 564.1nm.

[0093] Moreover, the Abbe number in d line of ** material by which nu 4 constitutes the 4th lens L4, The Abbe number in d line of ** material by which nu 5 constitutes the 5th lens L5, the Abbe number in d line of ** material by which nu 7 constitutes the 7th lens L7, The Abbe number in d line of ** material by which nu 8 constitutes the 8th lens L8, the Abbe number in d line of ** material by which nu 9 constitutes the 9th lens L9, and nu 10 show the Abbe number in d line of the ** material which constitutes the 10th lens L10. The anomalous-scattering nature of the ** material which constitutes the 4th lens L4 and dPgF5 dPgF4 [moreover,] The anomalous-scattering nature of the ** material which constitutes the 5th lens L5, and dPgF7 The anomalous-scattering nature of the ** material from which the anomalous-scattering nature of the ** material from which the anomalous-scattering nature of the ** material which constitutes the 7th lens L7, and dPgF8 constitute the 8th lens L8, and dPgF9 constitute the 9th lens L9, and dPgF10 show the anomalous-scattering nature of the ** material which constitutes the 10th lens L10.

[0094] The gestalt 6 of gestalt 6 implementation of operation has the structure replaced with either of the retro focus mold lenses 10 which explained the projection lens 7 of the projection mold display shown in drawing 13 with the gestalt of the above-mentioned implementation. In the projection mold display 300 of the gestalt 6 of operation, the dichroic prism 6 with big thickness is arranged between liquid crystal panels 5R, 5G, and 5B and the projection lens 7. Therefore, the following specifications and engine performance are called for in the projection lens which needs wide angle projection like a rear projector.

(1) Extensive field angle projection be possible.

(2) Have big back focal length compared with a focal distance.

(3) The tele cent rucksack nature by the side of a light valve is good, and the chief ray in a prism component is near in parallel to an optical axis.

(4) The chromatic aberration of magnification should be amended well.

(5) Distortion aberration is small.

(6) The desired image formation engine performance can be maintained with few focus gaps in a large temperature requirement.

(7) Various aberration is amended with sufficient balance good, and can project the subject-copy image on the light valve of high density and many pixels with high resolution.

[0095] By having satisfied above-mentioned engine-performance (1) – (7), and carrying this in the projection mold display shown in drawing 13 , the retro focus mold lens shown in the gestalt of the above-mentioned implementation can attain high definition nature and low cost nature, and, moreover, can realize the small projection mold display in which use in a large temperature requirement is possible.

[0096] Gestalt 7 drawing 14 of operation is the block diagram showing roughly the optical system of the projection mold display 301 concerning the gestalt 7 of operation of this invention. As shown in drawing 14 , this projection mold display 301 from a lamp 120 and a reflecting mirror 130 — becoming — abbreviation, while reflecting the light source 1 which carries out outgoing radiation of the parallel illumination-light bundle 2, the reflective mold liquid crystal panel 50 which displays a color picture, and the flux of light 2 from the light source 1 and irradiating the reflective mold liquid crystal panel 50 It has the polarization beam splitter 60 which makes the reflected light 20 from the reflective mold liquid crystal panel 50 penetrate, and the projection lens 7 which carries out expansion projection of the incoming beams 20 on a screen 8. In the gestalt 7 of operation, it is considering as either of the retro focus mold lenses 10 in the gestalt of implementation of the projection lens 7 of one of the above. In

addition, in drawing, 200 shows a case.
[0097] On the reflective mold liquid crystal panel 50, a reflective mirror is formed for every pixel, and the polarization condition in an exposure flux of light cross section and a spectrum are modulated. The modulation of a polarization condition is changed into intensity modulation because the flux of light 20 reflected with the liquid crystal panel 50 penetrates a polarization beam splitter 60, and an expansion image is projected on a screen 8 with the projection lens 7.
[0098] By having satisfied above-mentioned engine-performance (1) - (7), and carrying this in the projection mold display shown in drawing 14 , the retro focus mold lens shown in the gestalt of the above-mentioned implementation can attain high definition nature and low cost nature, and, moreover, can realize the small projection mold display in which use in a large temperature requirement is possible.
[0099] Gestalt 8 drawing 15 of operation is the block diagram showing roughly the optical system of the projection mold display concerning the gestalt 8 of operation of this invention. it is shown in drawing 15 — as — this projection mold display 302 — from a lamp 120 and a reflecting mirror 130 — becoming — abbreviation — it has the light source 1 which carries out outgoing radiation of the parallel illumination-light bundle 2, a condensing lens 140, and the color wheel unit 110. The color wheel unit 110 consists of a color filter 11 with which the primary color transparency field of R, G, and B carried out include-angle division, and was arranged, and a motor 12 which carries out the rotation drive of this. moreover, the projection mold display 302 — the rod integrator 13, the relay lens system 14, and an abbreviation tele cent — it has the TIR (total reflection) prism 600 to which total reflection of the light of a rucksack condition is carried out. The TIR prism 600 consists of the 1st prism block 601 and the 2nd prism block 602, and has the structure where opposite arrangement of the slant face of both blocks 601 and 602 was carried out through the minute air gap.
[0100] Moreover, the projection mold display 302 has the DMD (digital micromirror device) component 500 and the projection lens 7. The DMD component 500 is an image display component adapting a MEMS (micro electromechanical system) technique. The DMD component 500 is a space modulation element which arranged the minute micro mirror array in the two-dimensional side, and changes modulation control into two conditions of turning on and off of the inclination of each mirror in a component side. In the gestalt 8 of operation, it is considering as the retro focus mold lens 10 in the gestalt of implementation of the projection lens 7 of one of the above. In addition, in drawing, 200 shows a case.
[0101] Total reflection of the flux of light which carried out incidence to the slant face of the 1st prism block 601 is carried out to the ** material which constitutes prism by the refractive-index difference of an air gap AG, and it carries out incidence to the DMD component 500. Each field of the TIR prism 600 is penetrated, an expansion image is formed on a screen 8 with the projection lens 7, and the appreciation person's 9 appreciation is presented with the flux of light 20 reflected by the ON state of the minute mirror within the field of the DMD component 500.
[0102] By having satisfied above-mentioned engine-performance (1) - (7), and carrying this in the projection mold display shown in drawing 15 , the retro focus mold lens shown in the gestalt of the above-mentioned implementation can attain high definition nature and low cost nature, and, moreover, can realize the small projection mold display in which use in a large temperature requirement is possible.
[0103] In addition, it may replace with the DMD component 500 and a GLV (grating light valve) component may be used. A GLV element can carry out the accumulation array of the movable grating component with the controllable amount of phases with a MEMS technique according to an individual at the shape of a two-dimensional or 1-dimensional array, and can form a full color image by transposing the DMD component 500 of drawing 15 to a GLV element so that it may be well-known.
[0104] Moreover, the class of light valve component is not limited to what was shown in the gestalten 6-8 of the above-mentioned implementation.
[0105]
[Effect of the Invention] It is effective in the ability to perform aberration amendment outside a shaft

appropriately, reconciling tele cent rucksack nature with long back focal length reservation, since it is constituted according to the retro focus mold lens of claim 1 so that from conditional expression (1) to (4) may be satisfied as explained above. Moreover, by restricting small the shaft top power of the 1st lens which consists of plastic material, and the 12th lens, the operating temperature limits of a retro focus mold lens are extended, and it is effective in the ability to prevent the focal gap to a temperature change, and degradation of resolution.

[0106] Moreover, since according to the retro focus mold lens of claim 2 it is constituted so that conditional expression (5) may be satisfied, while being able to choose as arbitration the brightness and the image formation engine performance which were doubled with the property of an illumination system until it results in a projection lens, it becomes possible by enlarging eye relief by the side of a light valve to project the flux of light modulated with the light valve by which telecentric lighting was carried out by the good ambient light quantitative ratio.

[0107] Moreover, [0108] which becomes possible [it is possible to secure back focal length greatly, and / securing required suitable air spacing] when the cover glass which protects a thick prism component and the front face of a light valve between a light valve and a retro focus mold lens, and a projection system are mounted since according to the retro focus mold lens of claim 3 it is constituted so that conditional expression (6) may be satisfied moreover — since according to the retro focus mold lens of claim 4 it is constituted so that from conditional expression (7) to (12) may be satisfied, while controlling chromatic aberration (vertical chromatic aberration, chromatic aberration of magnification) appropriately and controlling the color gap of a primary color image by which expansion projection is carried out — high — the projection engine performance [****] is realizable.

[0109] Moreover, since according to the retro focus mold lens of claim 5 it is constituted so that from conditional expression (13) to (16) may be satisfied, also in the projection mold display using the light source which has the bright line spectrum of short wavelength, few good projection images of a flare component can be offered.

[0110] moreover — according to the retro focus mold lens of claim 6 — conditional expression (17) and (18) — until — since it is constituted so that it may be satisfied, also in the projection mold display using the light source which has a short wavelength spectrum, few good projection images of a flare component can be offered.

[0111] Moreover, according to the projection mold display of claim 7, high definition, low cost, and the small projection mold display that has the outstanding description that use in a large temperature requirement is possible are realizable.

[0112] Moreover, according to the projection mold indicating equipment of claim 8, the high definition and the low cost which carried the liquid crystal light valve, and the small projection mold indicating equipment which has the outstanding description that use in a large temperature requirement is possible are realizable.

[0113] Moreover, according to the projection mold display of claim 9, the high definition and the low cost which carried the light valve components (DMD etc.) which were manufactured by the MEMS technique, and by which the inclination of the unit mirror of a minute mirror array is controlled, and the small projection mold display which has the outstanding description that use in a large temperature requirement is possible are realizable.

[0114] Moreover, according to the projection mold indicating equipment of claim 10, the high definition and the low cost which carried the light valve components (GLV etc.) by which the amount of modulation phases by the unit grating of a minute grating array manufactured by the MEMS technique is controlled, and the small projection mold indicating equipment which has the outstanding description that use in a large temperature requirement is possible are realizable.

[Translation done.]

* NOTICES *
Japan Patent Office is not responsible for any
damages caused by the use of this translation.
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing roughly the retro focus mold lens applied by the gestalten 1-5 of operation of this invention.
[Drawing 2] About the retro focus mold lens concerning the gestalt 1 of operation, (a) shows astigmatism and (b) shows distortion aberration.
[Drawing 3] About the retro focus mold lens concerning the gestalt 1 of operation, (a) is a transverse aberration Fig. on a shaft, and (b) is the transverse aberration of the maximum image quantity.
[Drawing 4] About the retro focus mold lens concerning the gestalt 2 of operation, (a) shows astigmatism and (b) shows distortion aberration.
[Drawing 5] About the retro focus mold lens concerning the gestalt 2 of operation, (a) is a transverse aberration Fig. on a shaft, and (b) is the transverse aberration of the maximum image quantity.
[Drawing 6] About the retro focus mold lens concerning the gestalt 3 of operation, (a) shows astigmatism and (b) shows distortion aberration.
[Drawing 7] About the retro focus mold lens concerning the gestalt 3 of operation, (a) is a transverse aberration Fig. on a shaft, and (b) is the transverse aberration of the maximum image quantity.
[Drawing 8] About the retro focus mold lens concerning the gestalt 4 of operation, (a) shows astigmatism and (b) shows distortion aberration.
[Drawing 9] About the retro focus mold lens concerning the gestalt 4 of operation, (a) is a transverse aberration Fig. on a shaft, and (b) is the transverse aberration of the maximum image quantity.
[Drawing 10] About the retro focus mold lens concerning the gestalt 5 of operation, (a) shows astigmatism and (b) shows distortion aberration.
[Drawing 11] About the retro focus mold lens concerning the gestalt 5 of operation, (a) is a transverse aberration Fig. on a shaft, and (b) is the transverse aberration of the maximum image quantity.
[Drawing 12] (a) - (b) is drawing showing the ABBE line in each manufacturer.
[Drawing 13] It is the block diagram showing roughly the optical system of the projection mold display concerning the gestalt 6 of operation of the conventional example and this invention.
[Drawing 14] It is the block diagram showing roughly the optical system of the projection mold display concerning the gestalt 7 of operation of this invention.
[Drawing 15] It is the block diagram showing roughly the optical system of the projection mold display concerning the gestalt 8 of operation of this invention.
[Description of Notations]
G1 The 1st group lens G2 The 2nd group lens G3 The 3rd group lens, L1 The 1st lens L2 The 2nd lens L3 The 3rd lens, L4 The 4th lens The L5 5th lens L6 The 6th lens, L7 The 7th lens L8 The 8th lens, L9 The 9th lens, L10 The 10th lens L11 The 11th lens The L12 12th lens, STO It extracts. 1 Light source 7 10 Projection lens 5R, 5G, 5B Transparency mold liquid crystal panel 50 A reflective mold liquid crystal panel, 300,301,302 Projection mold display 500 DMD component.

[Translation done.]